REMARKS

Claims 1-10 are all the claims pending in the application. Of these claims, claims 1-4 are being examined in this application, as claims 5-10 have been cancelled as being non-elected. Applicants reserve the right to file a divisional application on the non-elected claims.

Claims 1-4 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Norstrom, et al. (U.S. Patent No. 4,459,162); Japanese Patent No. 2003-55747 (JP '747); Japanese Patent No. 2001-123247 (JP '247); Japanese Patent No. 2000-328195 (JP '195); and Japanese Patent No. 1-152242 (JP '242). For the following reasons, Applicants respectfully traverse the Examiner's rejections.

It is known that if high speed tool steel is manufactured by a powder sintering process, a fine carbide structure can be obtained. However, in order to realize mass production at low cost, use of an ingot casting process is desirable.

In the meantime, in order to realize mass production by the ingot casting process, it is necessary to produce a large-sized steel ingot. However, such a large-sized ingot often varies in composition of its carbides, and the product made of the tool steel obtained from the large-sized steel ingot often varies in tool performance (*see* specification at page 2, lines 8 to 15).

Consequently, it is an object of the present invention to provide a high speed tool steel manufactured by an ingot casting process using a large-sized steel ingot, in which a tool product made of the high speed tool steel is improved in toughness and in tool performance (*see* specification at page 2, line 25 to page 3, line 1).

The above amendment to claim 1 clarifies that the present invention does not relate to a high speed tool steel produced from a powder sintering process, but from an ingot casting process.

The fact that the present invention relates to a high speed tool steel made from an <u>ingot casting process</u> is clearly stated in the specification at page 20, lines 7 to 12, and other places, and thus, this is not a new matter.

Further, Applicants have amended to specification to correct a typographical error of 60°C to "560°C".

As stated in the IDS submitted at the time of filing the present application, the composition of the high speed tool steel of the present invention is the same as that of the high speed tool steel of the earlier application of the present applicant (JP02-008347). However, with respect to the ingot steel according to JP02-008347, higher toughness, i.e., improvement in the high impact value, is still desired.

The impact value of the tool steel of JP02-008347, which was determined by the notched Charpy impact test (10 mm R) as in the present invention, is shown in Table 3.

The impact value of the Specimen in Table 3 which has a quenching temperature of 1140℃ (as in table 2 of present application) was 16.1 kgm/cm^2 [= about 147 J/cm^2] (*See* the attached English translation of tables 1 and 3 of JP02-008347).

In the present invention, although the ingot casting steel has the same composition as that of JP02-008347, <u>a higher impact value is achieved</u>. In order to achieve the higher impact value, the present invention is mainly characterized by "novel dispersion of carbides".

That is, the present invention does not simply relate to the formation of fine grains of carbides on the basis of the technical idea that the grain size of the carbides is decreased. The present invention is based on the technical idea that fine grains of carbides (average grain size $\leq$ 0.5 μm) are further actively dispersed in extremely large number ($\geq 80 \times 10^3$ particles/mm^2). Thus, according to the present invention, in the high speed tool steel after quenching and tempering, a very high Charpy impact value of more than 100 J/cm^2, or even more than 200 J/cm^2 (which was not possible in the past) can be obtained without variation.

The dispersion of carbides of the present invention is not achieved by quenching and tempering of the ingot casting steel manufactured by the conventional method, such as that of JP02-008347, but is achieved by the special control of the distribution of carbides in the matrix of the steel ingot prior to quenching and tempering.

Each cited reference discloses a steel having the composition that is close to that of the steel of the present invention. However, none of the references provides for a high Charpy impact value of more than 200 J/cm^2 that can be achieved by the present invention. Moreover, unlike the present invention, the cited references do not recognize the need to improve the distribution of carbides in order to obtain such a high impact value. In short, the present invention as recited in the claims of the application achieved superior results which are not taught or suggested in the prior art applied by the Examiner.

U. Patent No. 4,459,162, Norstrom et al.

In Norstrom, the Cr content is limited to 3.5% or less, and thus Norstrom differs in the range of the composition from the present invention in which the Cr content is set at 4-6%. Table 1 of Norstrom shows Steel No. 2 (as prior art steel) containing 0.39% of C and 4.8% of Cr, which are within the ranges of the composition of the present invention. However, Norstrom describes that the prior art steel is poor in resistance to temper softening and toughness (tensile characteristics). That is, Norstrom states that the Cr content cannot be set within the range of the composition of the present invention.

In Norstrom, with respect to the dispersion of carbides, in order to impart resistance to temper softening, the vanadium carbides only are specified to have an average diameter not exceeding 0.1 μm (Claim 9). However, Norstrom does not describe the amount of dispersion and, unlike the present invention, does not take the dispersion density of all the carbides into consideration.

In Norstrom, as the treatment prior to quenching and tempering, only soft-annealing at a slow cooling rate, which is an ordinary manufacturing process, is performed (column 4, lines 5 to 7). Thus, it is not possible to achieve the high impact value of the present invention, the high impact value being achieved by improvement in the dispersion of the carbides.

Norstrom shows the tensile test values after quenching and tempering in the tests of mechanical properties shown in Figs. 2 and 3. Since Norstrom does not show the impact values, it is not possible to make comparison with the impact test values of the present invention. However, in Norstrom, the tests of mechanical properties are carried out at a low hardness of

HRC 47 (column, 3, line 43). Thus, it is not considered that the steel of Norstrom can achieve the impact test values shown in Table 2 of the present invention in which the tests are carried out at a high hardness of HRC 57. That is, it is not possible to obtain the density of the carbides of the present invention and the high impact value of the present invention only by ordinary soft-annealing.

Japanese Patent No. 2003-55747

JP '747 relates to a sintered steel by a powder sintering process, and thus belongs to a different technical field from that of the ingot casting steel of the present invention. JP '747 specifies the maximum grain size of carbides to be 0.6 μm or less and the average grain size of austenite crystals to be 0.6 μm or less. It is difficult to obtain such values by the conventional ingot casting process, and the values were achieved only by the powder sintering process.

However, in the powder sintering process, as described in JP '747, very small tools with a size of 200 μm or less are mainly targeted (paragraph [0028]). As described in the examples of JP '747, mechanical test values (not Charpy impact test values, but bending strength) are obtained only from the testing of thin wires of 0.2 mm (paragraph [0018]). Thus, it is difficult to meet the requirement of tools with the size usually used in many cases.

As described above, the present invention relates to an ingot casting steel that can also meet the requirement of large tools in which the values close to those that were only achieved by the powder sintering process can be achieved.

That is, since the steel of the present invention is the ingot steel, as shown in the examples of the present invention, the steel can be used for a re-melted ingot with a diameter of

580 mm obtained by the electro-slag melting process (*see* specification at page 20, lines 7 to 12), and can also used for a larger ingot (*see* specification at page 24, lines 7 to 11). Therefore, the present invention can be applied to large tools and steel molds. It is difficult to manufacture such large tools by the powder sintering process of JP ' 747, and even if manufactured, extremely high costs are incurred.

The present invention is a novel invention, in which the "amount of dispersion" of fine grains of carbides is determined in order to overcome the drawback that "toughness is insufficient and variations occur", which are inevitable in the conventional large-sized ingot steels. Such a consideration is not present in JP '747.

Furthermore, JP '747 specifies (2Mo +W) to be 15% or more, i.e., (Mo + 1/2W) being 7.5% or more. Thus, JP '747 differs in the range of the composition from the present invention, in which (Mo + 1/2W) is 1.5-6%.

As described above, the present invention is a novel invention, with a high technical level, that is different from the invention of JP '747.

Japanese Patent No. 2001-123247

JP '247 specifies the Cr content to be 1.0-4.0%. In view of Table 1, the targeted Cr content is substantially 2%. Thus, JP '247 differs in the range of the composition from the present invention, in which the Cr content is 4-6%.

Tables 1 and 2 of JP '247 disclose a steel having a Cr content of 5.0%, which is within the range of the composition of the present invention. However, the steel is considered as a comparative example, in which although the steel contains 4.21% by mass of fine grains of

carbides with a grain size of 0.5 μm or less, the total amount of the carbides is large, and the steel is poor in machinability. That is, JP '247 does not take the composition range of Cr of the present invention into consideration.

JP '247 describes that the total amount of carbides after quenching and tempering is specified to be 8% or less and the amount of fine grains of carbides with a grain size of 0.5 μm or less is specified to be 0.3 to 3%. However, the percentage of the amount of the carbides is in terms of mass, and the dispersion in terms of the number of carbide particles is not shown. That is, JP '247 does not recognize the need to control the carbides by the number of particles, i.e., to disperse carbides (average grain size ≤ 0.5 μm) at a density of equal to or more than 80×10^3 particles/mm^2.

Furthermore, in JP '247, a conventional cast ingot is formed into a steel product by an ordinary processing method, and then ordinary spheroidizing is performed at a slow cooling rate before quenching and tempering. Therefore, the resulting steel has the same carbide structure as that of the conventional tool steels, and it is evident that the density of the carbides of the present invention is not achieved.

Although the Charpy impact value of JP '247 is not known, since the steel of JP '247 is manufactured by the ordinary method, the impact value is considered to be normal.

Japanese Patent No. 2000-328195

In JP '195, the W content is specified to be 5.00% or more, unlike the present invention in which the W content is not more than 3.00%. In JP '195, by adjusting the carbides before

quenching and tempering, the hardness property (hardenability) after quenching and tempering is improved.

Tables 1 and 2 of JP '195 shows Comparative Example 4 in which the C content is 0.71%, the Cr content is 5.33%, the Mo content is 4.51%, and the W content is 1.02%, which are the ranges of the composition corresponding to those of the present invention. However, in Comparative Example 4, solid solution of carbides takes a long time during quenching, and this example is evaluated to be poor in hardenability. That is, JP' 195 does not take the range of the composition of Cr of the present invention into consideration.

Furthermore, in JP '195, in the annealed state before quenching, the occupancy ratio of carbides with a grain size of 1.0 μm or less is specified to be 60% or more of the total mass of the carbides. However, as in JP'247, the percentage of the amount of the carbides is in terms of mass, and the dispersion in terms of the number of carbide particles is not shown. <u>That is, JP '195 does not recognize the need to control the carbides by the number of particles, i.e., to disperse carbides (average grain size ≤ 0.5 μm) at a density of equal to or more than 80 × 10^3 particles/mm^2.</u>

Furthermore, the steel of JP'195 is manufactured by an ordinary process, in which an ingot is subjected to hot forging, and then annealing at a slow cooling rate is simply performed before quenching and tempering. Therefore, it is not possible to achieve the density of the carbides of the present invention.

Although the Charpy impact value of this specimen is not disclosed, as long as the steel is manufactured by the ordinary method, it is evident that the high impact value of the present invention cannot be achieved.

Japanese Patent 1-152242

JP '242 relates to a steel manufactured by a powder sintering process, and, as in JP '747, belongs to a different technical field from that of the ingot casting steel of the present invention. As described above, the present invention is characterized in that the tool steel is manufactured by the ingot casting process, not by the powder sintering process. In JP '242, the ranges of the composition are very wide, cover the ranges of the composition of the present invention, and permit excessive amounts of Mo, W, and V.

In JP '242, in order to evaluate toughness, a notched Charpy impact test (10 mm R) is carried out under the same conditions as those of the present invention. When the heat treatment conditions are compared with those of the present invention, it is assumed that the hardness of the test bar is substantially the same of that of the present invention. As is obvious from the impact values in Table 2, all of the specimens (Nos. 1 to 12) contain excessive amounts of Mo, W, and V, which exceed the ranges of the composition of the present invention. In addition, in spite of the fact that the steel is manufactured by the powder sintering process in which the homogeneous texture is easily obtained, the Charpy impact value is only 42 J/cm^2 [= 4.3 kgfm/cm^2], even at the highest (Specimen No. 3a).

In the ingot casting steel which generally has low toughness and is difficult to improve compared with the steel manufactured by the powder sintering process, the present invention can

achieve a high impact value of 200 J/cm^2 or more without variation. This is because of the "determination of the amount of dispersion" of fine grains of carbides, which is the feature of the present invention.

Namely, the present invention is a novel invention, with a high technical level, that is different from the cited reference.

Based on the foregoing, it is submitted that the claims patentably distinguish over the prior art. Indeed, it is submitted that the Examiner has failed to establish a *prima facie* case of obviousness in that the Examiner has failed to explain the specific features of the claims that are missing from each prior art reference, and to explain why a person of ordinary skill in the art would modify the prior art references to include the missing features. Instead, the Examiner has treated the references as a group, even though the § 103 rejection is based on the references individually. Further, even if a *prima facie* case of obviousness has been established, it has been fully rebutted herein based on the above deficiencies of the prior art and the unexpected superior results discussed above.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

Brian W. Hannon
Registration No. 32,778

SUGHRUE MION, PLLC
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

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P04502US Appendix

JP 02-008347 Table 1

	CHEMICAL COMPOSITION											
	C	Si	Mn	S	Ni	Cr	W	Mo	V	Co	Fe	Nb
INVENTIVE STEEL F	0.56	0.15	0.55	0.002	0.91	3.39	1.01	2.07	1.18	0.78	Bal.	0.16
CONPARATIVE STEEL I	0.55	0.15	0.56	0.002	0.85	3.34	1.02	2.05	1.13	0.79	Bal.	—

JP02-008347 TABLE 3

QUENCHING TEMPERATURE (℃)	COMPARATIVE STEEL I			INVENTIVE STEEL F		
	GRAIN SIZE OF AUSTENITE (JIS METHOD)	TENSILE STRENGTH AT 700℃	10R Charpy value (L) (kgm/cm^2)	GRAIN SIZE OF AUSTENITE (JIS METHOD)	TENSILE STRENGTH AT 700℃	10R Charpy value (L) (kgm/cm^2)
1100	9.0	51.5	17.5	9.0	52.2	19.2
1120	8.0	57.3	16.3	8.5	59.6	18.2
1140	8.0(70%)+4.0(30%)	62.0	14.8	8.0	62.3	16.1
1160	7.0(25%)+3.5(75%)	63.9	8.5	8.0	64.7	14.8
1180	6.0(10%)+2.5(90%)	65.1	5.0	7.0(70%)+3.5(30%)	65.8	7.3